NEWSLETTER

Number 9 **March 1990**

FEATURES

NEWS FROM THE WOCE-IPO

WOCE is underway, finally. After RV Polarstern deployed the SCM7 current-meter array across the Weddell Sea in the Southern Ocean, RV Meteor finished the WHP section across Drake Passage (S1/A21), and is working her way along part of S4 and S2/A12 to Africa.

With the collection of the first WOCE dataset, it is now possible to test some of the WOCE infrastructure, such as the data centres and project offices. With the set-up of the WHP Office (WHPO) at Woods Hole, USA and the WHP Special Analysis Centre (WHP-SAC) at Hamburg, FRG, the elements are in place for close co-operation. The WHP Committee under Peter Saunders discussed these, and other issues, at its meeting in La Jolla, USA at the end of January. In February, data managers of the proposed regional Data Assembly Centres for the Voluntary Observing Ship Programme (VOS) discussed data streams, interaction between the centres and customer relations in Tallahassee, Florida. It was followed by a meeting, organized by Raymond Pollard and George Needler, to define further details of the WOCE Surface Layer Programme.

To promote WOCE and establish closer links with USSR scientists interested in WOCE, Vladimir Kamenkovich organised a WOCE Seminar in Svernigorod, near Moscow, USSR from 15-17 January 1990. A large audience participated in discussions on possible contributions to WOCE. Visits to some institutes in Moscow and Leningrad later were very useful for discussion of the Soviet involvement in this global WOCE programme.

The IOC WESTPAC meeting in Hangzhou, PR China in February provided a good opportunity to present WOCE to representatives from south-east Asia. The main focus, though, was follow-up work in defining the People's Republic's involvement in WOCE, particularly in deep ocean work in the West Pacific.

All these activities highlight IPO work that is now concentrating on ensuring further commitments to WOCE in areas where there are shortfalls and firming up potential contributions which are not clearly identified. This is a consequence of the Assessment of WOCE, which has been prepared by the IPO during the last few months. It reflects what the IPO and the SSG at present know about what will happen in WOCE. The

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many details which have been collected from various sources are summarized here for two purposes. All readers of the Newsletter are urged to check for accuracy the information that is relevant to their interest and involvement. If it is not accurate, they are asked to provide updated information to the IPO. The IPO has to prepare a final Assessment for the First Session of the Intergovernmental WOCE Panel in October in Paris at the IOC. At the IWP governments will appraise the status of the World Ocean Circulation Experiment, and will be asked to come forward with additional resources. The appraisal will be based on the Assessment you are now asked to check.

The following Assessment starts with statements of the chairpersons of the three Core Project Working Groups: Lynne Talley, Allyn Clarke, Arnold Gordon and John Gould. They present their interpretations of where the respective Core Projects stand in WOCE. Evaluations of components of the field programme are presented in the form of summaries, tables and figures. The tables identify components by principal investigator, time frame and country and sometimes indicate restrictions on the commitment. This entire assessment focuses on the WOCE field programme. A review of the modelling programme in WOCE, and how it interfaces with the field programmes, will be prepared soon. A continuing review of this Assessment, and of the implications for achieving the goals of WOCE, must be carried out before the Panel meeting in Paris. There WOCE will have to ensure its longevity as an experiment during the Intensive Observation Period. It will also lay the foundations for its Goal 2, which is to develop a global ocean observing system for climate change.

K P Koltermann
WOCE International Project Office

WOCE HYDROGRAPHIC PROGRAMME SPECIAL ANALYSIS CENTRE WHP-SAC

The WOCE Hydrographic Programme Special Analysis Centre (WHP-SAC) has been established in Hamburg, FR Germany. It will collect all finalized WHP-data, create specific products arising from the WHP and will assimilate data from other components of the experiment. It will finally produce the merged and the gridded WHP data sets. The WHP-SAC is a joint operation of the Deutsches Ozeanographisches Datenzentrum (DOD) as the German NODC, the Institut für Meereskunde, the Max-Planck-Institut für Meteorologie and the Deutsches Klima-Rechenzentrum, all in Hamburg.

The WHP-SAC will receive from the WHP Office in Woods Hole, which is the WHP Data Assembly Centre, all final, quality-controlled WHP data. WOCE Working Groups will generate products for planning and interpretation purposes on request with the understanding that P.I. data proprietary rights within the statutory two years after collection are respected. The SAC will finally produce "the WHP data set", which is planned to be a merged WHP data set that retains the original cruise-oriented structure and a gridded WHP data set. The latter will be available for modelling purposes of all kinds, and constitutes an important tool for the development of assimilation techniques. In the end, it is the data set that will be used when different WOCE data sets, ie the Global Drifter Data Set will have to be assimilated into the appropriate models. In the future resources and support for several visiting scientists will be available at the WHP-SAC.

At present the WHP-SAC is collecting recent hydrographic data sets that are considered to meet WOCE requirements. These will be used by the Data Quality Experts working with the WHP Office and others to assess the quality and consistency of the incoming data.

Jens Meincke at the Institut für Meereskunde will be in charge of the scientific aspects and Chris Brockmann at DOD of the data exchange aspects. Later on Klaus Hasselmann will take the lead in model-supported gridding of the WHP observations. They can be contacted by mail or on Omnet/telemail through WOCE.WHPSAC, IFM.HAMBURG, DOD.HAMBURG, or MPI.METEOROLOGY. They report, similar to the Director of the WHP Office, Terry Joyce, to the WHP Planning Committee.

WOCE RESOURCE ASSESSMENT

Core Project Reviews

Core Project 1

At the present time, one of the most serious concerns for WOCE Core Project 1 is the uncertainty associated with the scatterometer sensors. With NSCAT delayed at least to the later part of WOCE, we will have only the less capable sensor on the ERS satellites to provide global estimates of surface wind stress. Even for these satellites, ERS-2 is still just a proposal and it is most likely to be launched some months following the end of the expected lifetime of ERS-1. The other key elements of the air-sea flux program are either committed or planned.

In the surface layer, the delay in development of affordable XCTD probes that are deployable from merchant vessels will mean that there will be little improvement in our ability to estimate the fresh water flux into the upper ocean. This will make it difficult to model the seasonal and interannual variability of the upper layers at higher latitudes. WOCE will attempt to obtain temperature and salinity profiles from fisheries and other agencies who are known to collect such data in various regions. With regard to the upper ocean temperature field, adequate coverage should be attained over the Atlantic and Pacific Oceans north of 30°S; the coverage of the Indian Ocean will be increased but will remain sparse. If the 10% drop of XBT profiles in the North Pacific continues, this would be of some concern since the North Pacific does have the best long term data describing its upper ocean temperature field. Altimetry and the surface drifter program will provide global descriptions of the surface velocity field.

By including long CTD sections occupied in the late 1980's, we should have a good modern global hydrographic data set with a full suite of small volume tracers. There is some concern about the fact that these data will have been collected over periods of more than a decade; however, the repeat hydrography and the high density XBT sections, which are also well subscribed, should provide some information concerning inter-annual variability. Considerable work remains to be done to identify the nations and research groups to insure that enough repeat work is done in the Indian Ocean to define its very strong seasonal and interannual variability. There may also arise serious shortfalls in the collection of large volume tracers in the Pacific and Indian Oceans due to the capabilities of the vessels occupying the sections, funding and shortage of personnel to run the analyses.

Many of the mooring arrays designed to measure transports along boundaries or through passages are likely to be occupied as are many of the deep float releases. In the case of the heat flux arrays, work needs to be done to coordinate the mooring work with the hydrographic work and sponsors for some of these important arrays remain to be found. Most of the mooring arrays left with no expression of interest are eddy mapping arrays or arrays that have recently been occupied. In the deep float work, plans have not yet been formulated for coordinated releases in the North Atlantic, particularly releases associated with the spreading of particular water masses and the flow across the equator. This reflects the fact that intensive work in the North Atlantic will be carried out in 1993 and following and in conjunction with the Core Project 3 work in this region.

Core Project 2

This Core Project, addressing the Southern Ocean, lacks the commitment of resources to measure the velocity fields at different depths, ie drifters and floats. A component specific to this Core Project, the Eddy Kinetic Energy Statistics Moorings along the Antarctic Circumpolar Current in regions of high and low energies, are better covered than it appears in the assessment. Some have been done in the recent past, some are under negotiation; commitments are still needed for SCM12 to SCM14. On the other hand, mooring work is already very well underway with the multi-year SCM7 having been deployed in November 1989. The important Choke Point Arrays are being positively considered. In Drake Passage an array design will use results from earlier work in the 1970s; south of Australia a joint Australian/US programme is taking shape. The wide passage south of Africa will be reconsidered in view of available resources and potential new approaches.

The WHP coverage looks satisfactory. Regarding the repeat hydrography, a more homogeneous approach in the coverage has still to be achieved. A major question still is adequate sampling for temperature and salinity, be it on research ships or ships-of-opportunity, to estimate temporal and spatial changes in the heat and fresh-water storage and its changes. In order to obtain these data collaboration with other agencies and international bodies to jointly deploy drifting buoys with thermistor chains and air pressure sensors is being actively pursued.

In an area as devoid of other local research activities as the Southern Ocean, a close collaboration with existing and planned research programmes outside WOCE is required to make optimal use of the resources to obtain an adequate dataset.

Finally, the Core Project 2 is as much affected as the other Core Projects by delay or gaps in the satellite coverage which is required for the estimation of global wind-stress fields. This uncertainty needs to be quickly addressed and positively resolved.

Core Project 3

The present status of WOCE Core Project 3 is satisfactory in terms of the commitment of resources, but the shape of the scientific programme is still evolving. Commitments to the Deep Basin Experiment (USA, France, FRG) and to the Tracer Release Experiment NATRE (USA, UK) are strong, too. Two control volumes CV III (UK) and CV IV (Canada) are firm. The subtropical gyre is less satisfactorily covered in terms of the overall gyre scale experiment but the NATRE and the US subduction/ventilation experiments will be carried out there.

There are several new initiatives which are still in the process of formulation and which will have a significant impact on the Core Project 3 objectives. These are:

1. US NOAA Atlantic Climate Change Programme (ACCP) which will bring significant resources to bear on North Atlantic Core Project 3 research,
2. The expressed interest of the USSR to participate actively in WOCE Core Project 3, particularly in the repeat WHP work,
3. UK initiatives aimed at a study of thermocline ventilation of the subpolar gyre and its interface with the subtropical gyre.

The outcome of the recent (February 1990) WOCE Surface Layer Programme meeting will also have a strong impact on WOCE Core Project 3.

It is as yet too early to describe in detail the interaction between the various, and particularly the new, components but the overall resources which now appear to be available for Atlantic Core Project 3 research will, if properly managed enable Core Project 3 goals to be attained. Core Project 3 activities are likely to peak late in the WOCE Intensive Observation Period, that is after 1992. This will coincide with the required satellite coverage.

A key element in providing a framework for Core Project 3 will be the provision of the enhanced basin-scale coverage called for in the Implementation Plan. This must in some way be assured particularly via the insonification of the North Atlantic as a means of enabling RAFOS float deployments.

Satellites

The schedule for satellite sensors to be flown during the 1990s that will contribute to the WOCE dataset are shown in the table.

Altimetry

The ESA satellites, ERS-1 and ERS-2, are scheduled to be launched in early 1991 and mid-1994, respectively, which could leave a gap in coverage if the lifetime of ERS-1 does not reach the maximum expected. The chosen orbit for ERS-1, while adequate for WOCE altimetric purposes, is not optimal. The high-precision altimetric mission, TOPEX/POSEIDON, should be launched in mid-1992 and extend throughout the WOCE field phase. The launch of SPINSAT in mid-1990 as a replacement to GEOSAT, with an improved altimeter and GPS, will give additional coverage.

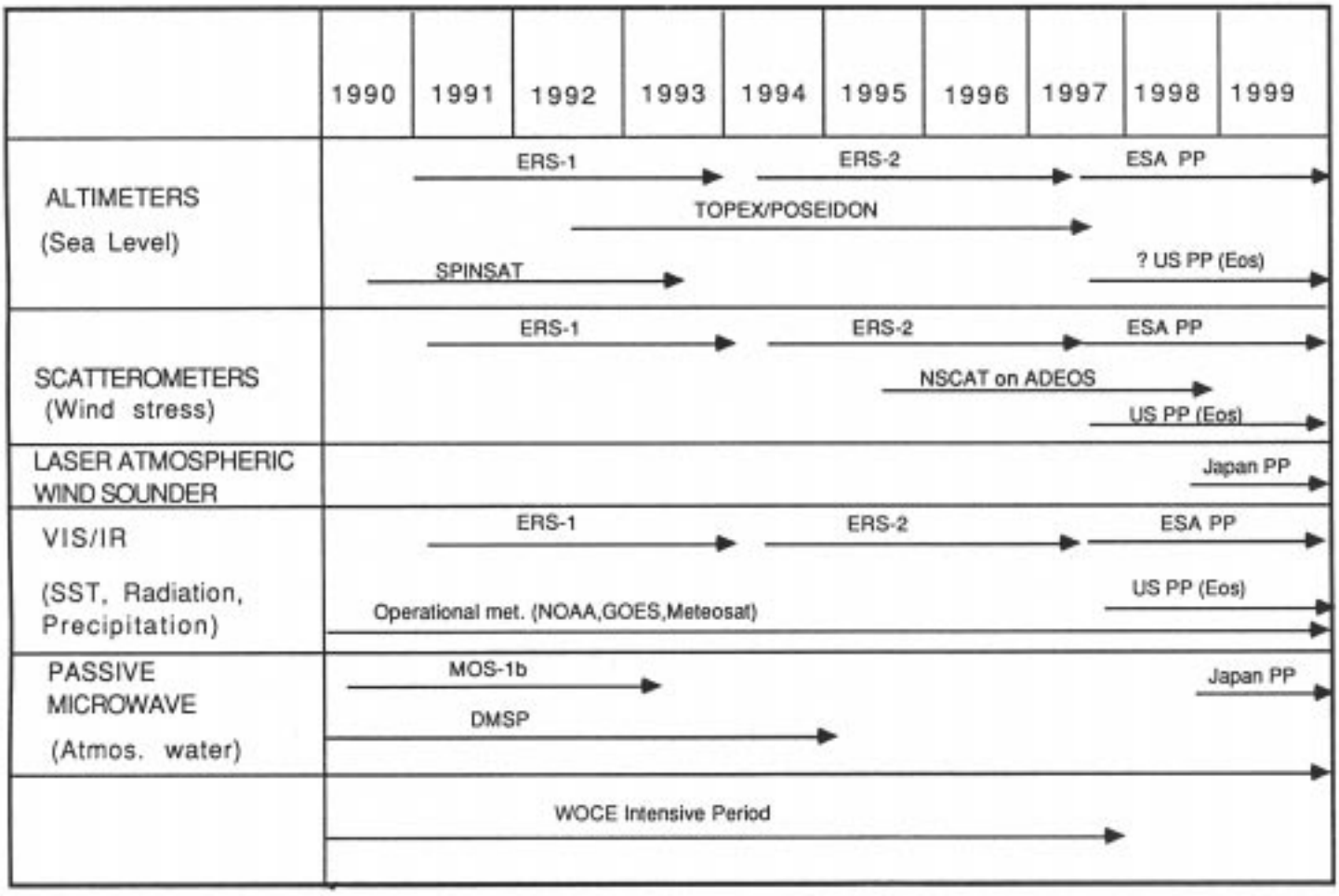
It is of concern that neither NASA or ESA seem to be giving high priority to a gravity mission which is necessary for WOCE for the determination of the ocean surface elevation relative to geopotential surfaces.

Scatterometers

Until the launch of NSCAT and ADEOS, scheduled for mid-1995, WOCE is dependent on the scatterometers to be flown on ERS-1 and ERS-2. As noted above there is the possibility of a gap in coverage between the two missions. A loss of scatterometer data between missions will make it difficult to create the consistent multi-year global air-sea flux dataset that is needed to force the WOCE global ocean models.

Other Missions

In addition to sensors flown on ERS-1 and -2, operational meteorological satellites, MOS-1B and DSMP will be carrying infra-red and microwave instruments during WOCE to measure sea-surface temperature, radiation, precipitation, etc. In conjunction with atmospheric general circulation models these will provide data to the level of accuracy that had been expected during WOCE.



Main satellite sensors for WOCE (anticipated lifetimes shown by arrows)

Sea Level

The sea level stations selected for the WOCE network are all in operation and expected to remain so. Thirty-nine of the 66 WOCE stations have satellite transmission facilities. None of the 21 Indian Ocean stations, however, have satellite transmission capabilities and only one does in the Southern Ocean (So. Orkney). The Indian Ocean island network is fairly complete and if the transmission situation were improved it would be ideal for WOCE purposes. The Pacific network, which is basically the TOGA network, is operating most efficiently in co-operation with the University of Hawaii which has acted as the TOGA/IGOSS centre for several years and now begins its operation as a WOCE centre as well. Improvements are being made in the Atlantic where France is installing 5 satellite transmitters and Sweden and Germany are installing 5 gauges along the West African Coast under a GLOSS project. The WOCE network remains thin in high latitudes. The IOC is co-ordinating an evaluation by 11 countries of whether the Antarctic network can be expanded.

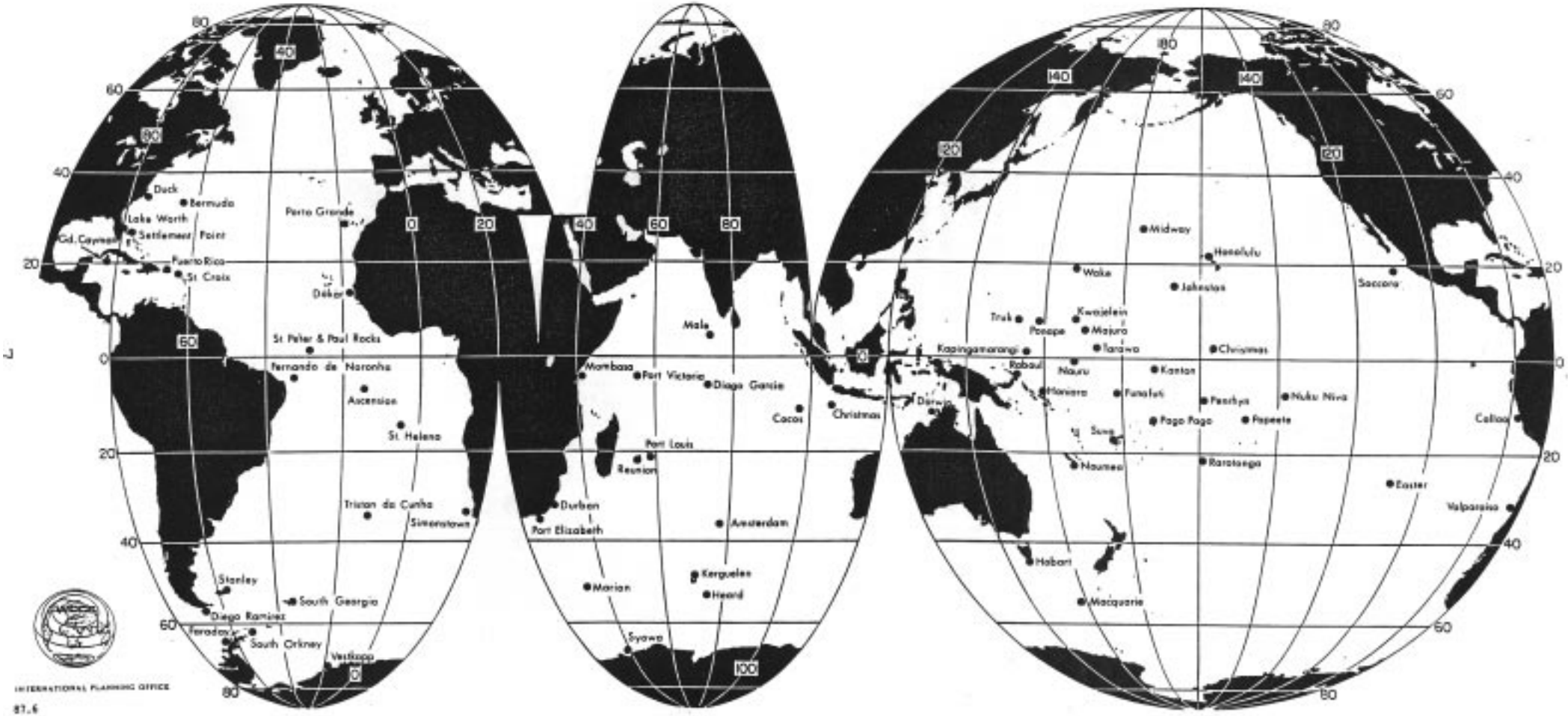
WOCE Sea Level Network

Atlantic		Indian		Pacific	
Bermuda	S	Cocos		Hobart	S, V
Porto Grande	S	Reunion	D	Macquarie	
Dakar	S, D	Christmas		Darwin	
Tristan da Cunha	S, D	Diego Garcia	(D)	Christmas	S
St. Helena	S, D	Mombasa		Ponape	S
Ascension	S	Port Louis		Tarawa	S
Stanley	S	Port Victoria		Majuro	S
So. Georgia		Male		Nauru	S
Simonstown		Heard		Rabaul	S
So. Orkney	S, D - Signy	Port Elizabeth		Honiara	S
Faraday		Durban		Rarotonga	S
Vestkapp		Amsterdam	D	Callao	S
Duck	S	Kerguelen	D	Kapingamarangi	S
Lake Worth	S	Marion	D	Johnston	S
Settlement Pt.	S	Syowa	(V)	Valparaiso	S
Gd. Cayman				Kanton	S
Puerto Rico	S			Easter	S, D
St. Croix	S			Nuku Niva	S
Diego Ramirez				Penrhyn	S
St. Peter & Paul Rocks				Wake	S
Fernando de Noronha	S			Funafuti	S
				Noumea	S, D
				Socorro	D
				Suva	S
				Kwajalein	S, V, (D)
				Honolulu	S, D - Maui, V - Kauai
				Truk	S
				Pago Pago	
				Midway	S
				Papeete	

Key

S = Satellite Transmission
D = Doris
V = VLBI
( ) = Planned

WOCE Sea Level Network



INTERNATIONAL PLANNING OFFICE

87.6

Moored Arrays

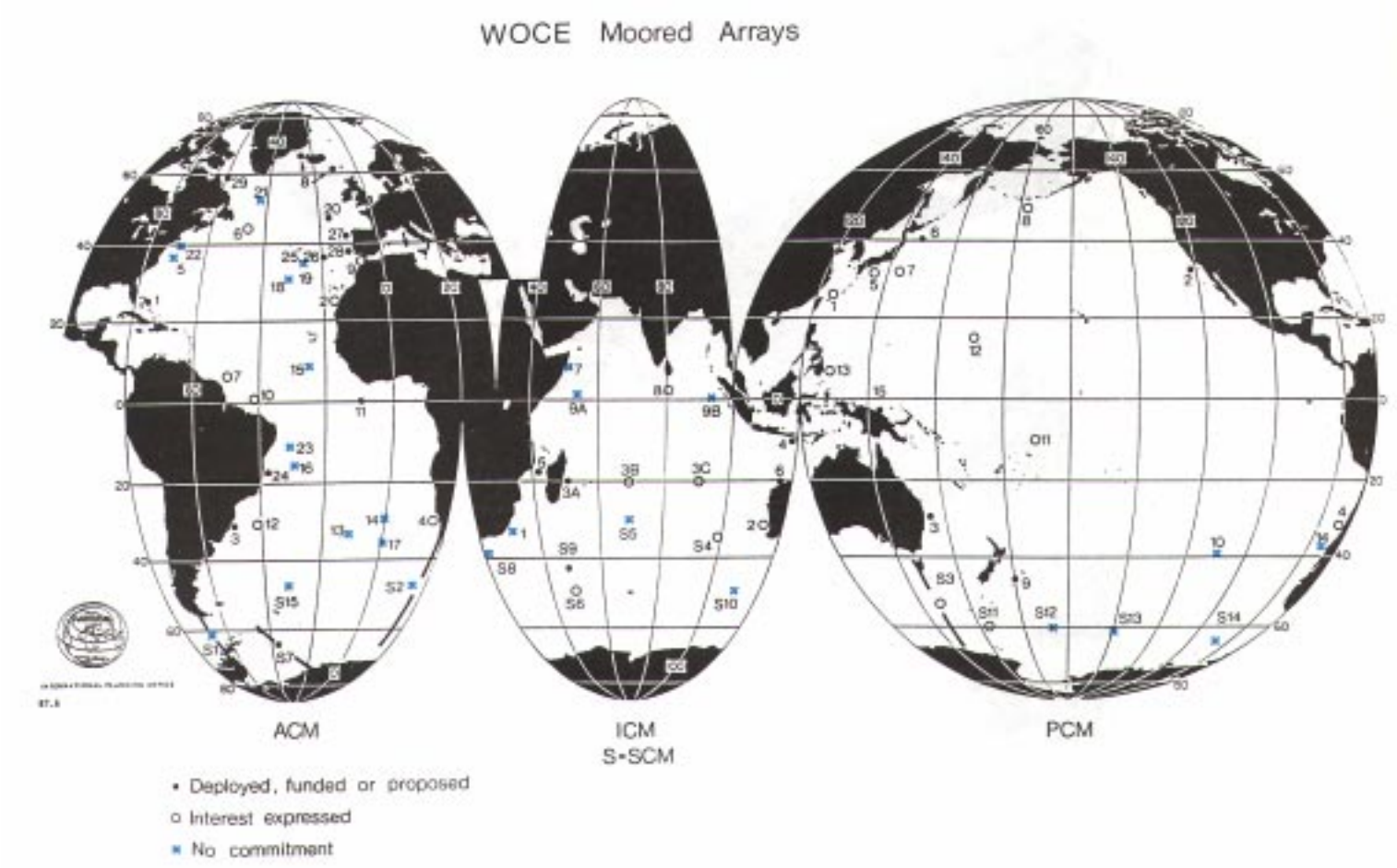
The mooring arrays have been designated in three ways: arrays for which proposals for implementation at a specific time have either been funded or are under consideration; arrays for which there is a national commitment but no proposal exists; and arrays for which there is no sponsor. Arrays in the second category must be considered as much more tentative than those in the first category.

Pacific Ocean

In terms of percentage of arrays subscribed, the Pacific Ocean is the most completely implemented of the four oceans (13 of 15 arrays). The four heat flux arrays (PCM 1, 2, 3, 4) are committed. The western and northern boundary current arrays (PCM 5, 6, 7, 8, 9, 15) are covered. Two of three (PCM 11, 12) arrays designed to measure exchange between deep basins are subscribed. Array PCM 14 which measures the deep circulation along the eastern boundary is not committed. The seven arrays which are scheduled span the time period 1990-94; six have no dates.

Southern Ocean

Less than half the Southern Ocean arrays (6 of 15) are committed. Of the three Choke Point arrays only the Australian (SCM 3) is committed; it should be remembered that the South American choke point (SCM 1) was well measured during ISOS. Two of three arrays to measure flow of AABW into the Indian Ocean (SCM 4, 6) are covered but there are no dates scheduled. Only SCM 15) of the eight eddy statistics moorings is committed; SCM 8 did not receive high priority from CP2 because of previous measurements obtained there. Scheduled moorings fall within the 1990-92 time frame.



Atlantic Ocean

The overall national commitments to the moored array program covers 19 of 30 moorings. All four heat flux moorings (ACM 1, 2, 3, 4) are subscribed but there are no dates yet assigned to the eastern boundary arrays. Western boundary current arrays, except for ACM 5, which is a site for which already there are long velocity records, are also committed (ACM 6, 7, 24, 29); of these only ACM 7 has no date attached to it. The two moorings designed to measure the transport of water into the Atlantic from the adjacent seas (ACM 8, 9) are covered. Eddy statistics moorings (ACM 15, 16, 17) along with the Deep Basin Experiment site mooring (ACM 23) do not have sponsors. There are commitments for 3 of 5 moorings (ACM 10, 11, 12) designed to measure exchanges between major deep basins. Control volume moorings are only weakly subscribed with only one (ACM 20) of five committed. Both Ekman layer and subduction moorings (ACM 25, 26) and eastern boundary current moorings off Portugal (ACM 27, 28) are committed. Of the arrays that have been scheduled 13 of 14 will be done in the 1990-92 period.

Indian Ocean

Nine of 13 Indian Ocean arrays are spoken for. The eastern 30°S heat flux array is covered but the western array is not. The three 20°S deep boundary current arrays (ICM 3A, B, C) are committed as well as the 20°S eastern boundary current array (ICM 6). A portion of the Indonesian throughflow array (ICM 4) is now in the water with an augmentation planned for later in WOCE. The Mozambique Channel array (ICM 5) is committed. There is no plan to deploy the Somali Current array (ICM 7) or the two equatorial arrays (ICM 9A, B). The ICM 8 array in the seasonally reversing SW/NE Monsoon Current is committed (no date). Most of the Indian Ocean work is planned for the 1993-1995 period.

WOCE Moored Arrays

(*Funded, deployed or proposal under review)

1990	1991	1992	1993	1994	1995	No date	No Commitment	
Pacific Ocean								
PCM9 (US/NZ)* PCM15 (US/Aus)*	PCM3 (Aus)*	PCM2 (US)* PCM8 (Can)	PCM11 (US)	PCM1 (US/J/PRC)		PCM4 (US/Chile) PCM5 (J) PCM6 (US)* PCM7 (J) PCM12 (J) PCM13 (US/PRC/J)	PCM10 PCM14	
Southern Ocean								
SCM7 (FRG)*	SCM9 (F)*	SCM3 (US/Aus) SCM6 (UK)				SCM4 (Aus) SCM11 (Aus)	SCM1 SCM2 SCM5 SCM8 SCM10	SCM12 SCM13 SCM14 SCM15
Atlantic Ocean								
ACM1 (US)* ACM7 (FRG) ACM8 (UK)* ACM20 (FRG)* ACM29 (Can)*	ACM3 (FRG/US)* ACM4 (US) ACM12 (FRG) ACM25 (US)* ACM26 (US)* ACM27 (Port)* ACM28 (Port)*	ACM10 (US/FRG/F) ACM11 (F)* ACM24 (US)*	ACM6 (Can)			ACM2 (US) ACM9 (S) ACM11 (US)	ACM5 ACM13 ACM14 ACM15 ACM16 ACM17	ACM18 ACM19 ACM21 ACM22 ACM23
Indian Ocean								
ICM4 (F)*			ICM6 (Aus)* ICM5 (F)*	ICM3B (US) ICM3C (US)	ICM3A (F/US)*	ICM2 (US/Aus) ICM4 (US) ICM8 (FRG)	ICM1 ICM7 ICM9 A, B	

Float Programme

There are three types of floats to be deployed at middepths during WOCE. SOFAR floats are sound sources that are tracked by an array of moored listening stations. RAFOS floats are drifting listening stations that record signals from moored sound sources and at the end of their lives relay their data through the ARGOS satellite system. ALACE floats are autonomous floats that are repeatedly located when they rise to the surface for satellite positioning. A hybrid of the ALACE and RAFOS technologies (ALFOS), which is an autonomous float capable of recording loud sound source data, is now under development. It is expected that it will be used in the later period of WOCE.

The WOCE target spatial resolution for global mapping of middepth velocity for computation of absolute geostrophic velocity is a 500 km square. This translates into the following numbers of floats in each ocean: Atlantic - 225; Indian - 180; Pacific - 495; and Southern - 200. At this time the planned float programme falls short of the target resolution. A large commitment of floats in the later stages of WOCE will be needed to meet the requirements.

Atlantic Ocean

In connection with the Deep Basin Experiment, 300 2-year RAFOS floats will be deployed by the US in the South Atlantic beginning in 1991. Depths will be 2,000 and 4,000 m. There is a possibility that France in WOCE will carry out a float deployment (250 ALFOS/RAFOS floats) between 30°S and 5°N in the Antarctic Intermediate Water. At present there are no plans for large-scale deployment of floats in the North Atlantic. A few floats may be released in the North Atlantic in support of Control Volume Experiment 3 (UK) and the Tracer Release Experiment.

Pacific Ocean

In the Pacific, ALACE floats will be deployed with a spacing of 250 km from WHP ships. In 1990 about 50 floats will be released on WHP lines P16 (central Pacific) and P19 (eastern Pacific). In 1991 100 ALACE floats will be released on lines P6, 7, 12; the total number of ALACE floats planned for the Pacific is 400. Depths of 500-800 m will be targeted. The US will start to insonify the N. Pacific in 1991 and the basin will be fully insonified by 1993. Roughly 225 RAFOS floats are planned for the N. Pacific; the first batch of 60 RAFOS will be released in 1991. Japan is planning to launch between 20 and 35 RAFOS floats with 250 km resolution along 165°E (P13) in 1991.

Indian Ocean

Since the US Indian Ocean WHP programme is slated for late WOCE, the implementation of the US float programme will also be delayed to the same period.

Southern Ocean

Ten ALACE floats have been deployed in Drake Passage in January 1990 on S1. About 16 ALACE floats will be deployed on lines P16 and P19 in the Southern Ocean (south of 40°S) and 10 ALACE on P12 in 1991.

Float Deployment Schedule

	1990	1991	1992	1993	1994	1995
Atlantic Ocean		300 RAFOS	50 RAFOS	← 200 ALFOS/RAFOS →		
Pacific Ocean	50 ALACE	20-35 RAFOS 60 RAFOS 100 ALACE	← 180 ALACE	175 RAFOS → 80 ALACE		
Southern Ocean	18 ALACE	8 ALACE				

Surface Velocity Programme

The SVP plans are to seed the Pacific Ocean in 1991 and keep it operational for 4 years. The Atlantic Ocean will be seeded in 1992-93 for 4 years. The Indian Ocean and Southern Ocean proposals, commitments and time schedules will not materialize until 1992.

The planned programme for drifter deployments in the Pacific and Atlantic Oceans are summarized in the table. Programmes that are funded are indicated by an asterisk; those that are indicated by a double asterisk are proposed; and those for which an interest has been expressed but the present status is uncertain are unmarked. "Equivalent" indicates that complete drifters will not be supplied but the monetary equivalent in partial drifters will be supplied.

Atlantic Ocean		**Time period**
Portugal**	30 drifters total	1991-92
UK	120 driters total	1992-95
USSR**	80 drifters (equivalent)	1992-95
Brazil**	50 drifters (equivalent)	1992-95
Nordic Group	20-60 drifters total	1990-94
USA*'**	50* (subduction experiment); 140** drifters	1992
South Africa) Netherlands)	Expressed interest but no plans yet	
FRG	Numbers to be determined	1992-93

Pacific Ocean		**Time period**
Japan*	30 drifters per year	1990-94
USA*	675 drifters total	1990-92
France*	30 drifters total	1990
Australia**	15 drifters per year	1990-93
Taiwan*'**	12* drifters; 16** drifters per year	1990; 1991-93
Korea**	20 drifters per year	1991-94
Canada**	174 drifters total	1991-94
Chile**	No drifters but deployment platforms offered	?

XBT Network

There are two modes of XBT sampling: designated lines for time series analysis; and spatially distributed sampling (broadcast mode) to map heat content.

At the present time the ship-of-opportunity sampling program does not include XCTDs. Unless this instrument becomes operational, a salinity sampling program will be designed. The WOCE XBT depth requirements are 1000 m (T5) along western boundaries and in high latitudes and 750 m (T7) elsewhere.

Atlantic Ocean

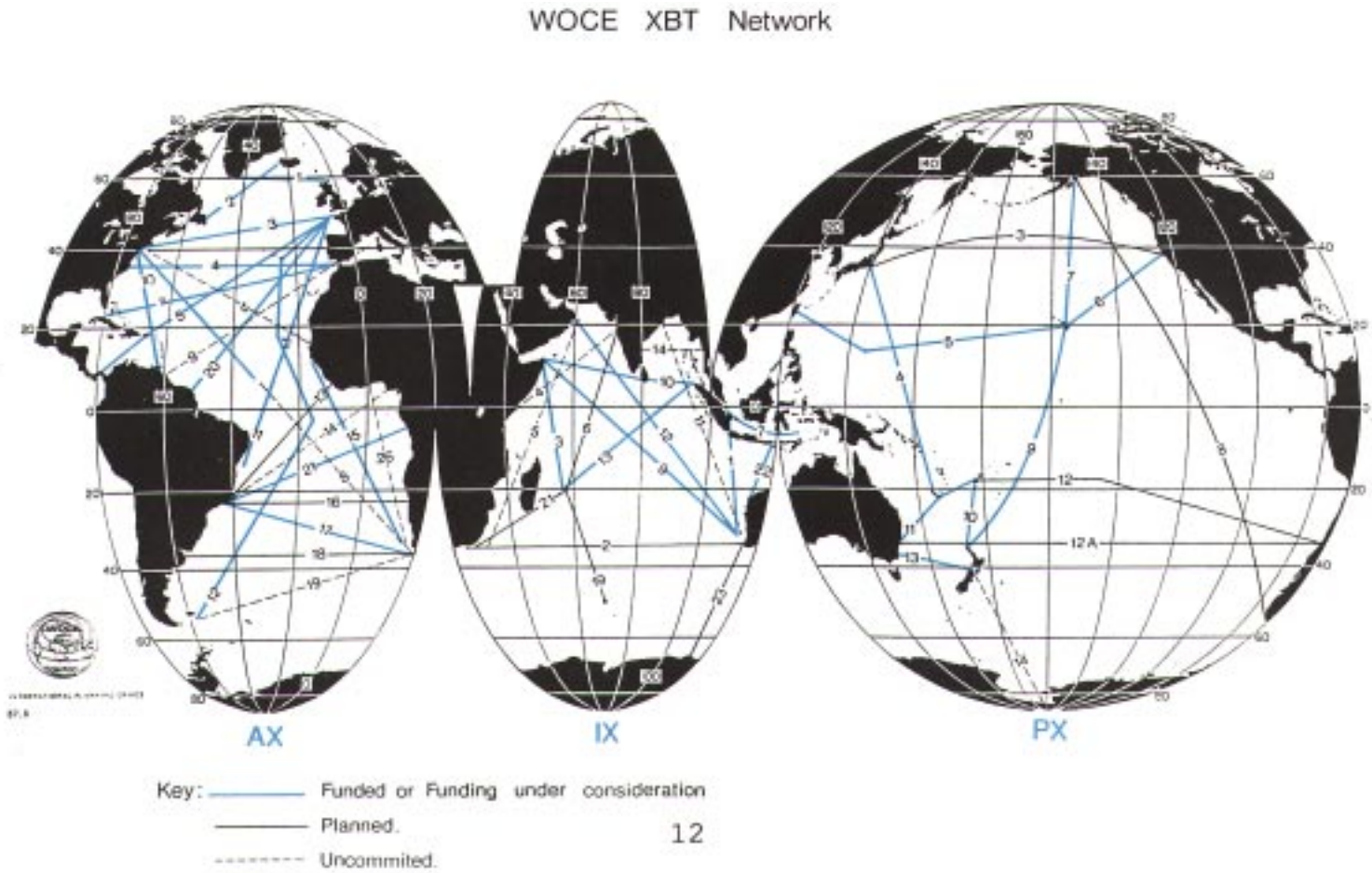
Seventeen of the 22 WOCE Atlantic XBT lines are either operational or funds are being sought for operation by 1991. This will result in approximately 60% of the required XBTs (monthly, 2 XBTs per day) being obtained. All lines, however, are to be sampled at a minimum rate of 4 per day, exceeding the WOCE requirements. Only 3 lines (AX 3, 17 and 21) will sample to 1000 metres (T5). The T7 is the main probe utilized with a few T4 (450 m). Additional data, BATHYs and TESACs from IGOSS and TOGA in the tropics, supplement the WOCE network.

Indian Ocean

Expected coverage in the Indian Ocean, is roughly 45% of the requirement, even though there will be some activity along 13 of the 17 WOCE lines. T7 will be used and the number of probes deployed on a given transect will normally exceed WOCE requirements. XBT activity south of 35°S is close to nil. TOGA is operating north of 30°S (where the TOGA and WOCE networks are identical) roughly at the 60% level.

Pacific Ocean

The WOCE XBT requirements in the Pacific are of a different nature than the Atlantic and Indian Oceans in that 13 High Density (seasonal, 12 XBTs per day, 1000 m) eddy resolving lines have been identified along with the lower density sampling based on TOGA, TRANSPAC and IGOSS. The TOGA network in the Pacific now fulfils 100% of TOGA requirements in terms of probes expended, but is deficient in coverage in the south-east sector. A majority of TOGA Pacific probes are T4, so they do not fulfil the WOCE depth sampling requirement (750 m). Outside of the tropical belt (30°N-30°S), there has been about a 10-20% decrease in the XBT activity both in TRANSPAC and IGOSS. If the sampling on the TOGA lines could be extended from port to port, some of the extra-tropical shortfall would be redressed. Funding for WOCE high density lines PX4, 5, 6, 7, 9, and 10 is under consideration in the US; PX13 will be done by Australia. Only lines PX3, 8 and 12 are unplanned at the present time.



WOCE XBT Programme Status

Line	Country	Secs/year	Probes	XBTs/day
AX 1	UK/Canada	Intermittent	T7/T7	
2	Canada	5	T7	
3	FRG	12	T7-T5	12
4	Portugal/US	12	T7	4
5	FRG/France	Intermittent/7	T4/T4	2/4
6				
7	(USA)*	12	T7	4
8	USA	12	T7	4
9				
10	USA	12	T7	4
11	FRG	8	T4-T7	2-6
	France	10	T4	4
12	(USA)	8	T7	
13	(Brazil/USA)	12	T7	4
14				
15	France	12	T7-T4	4
16	(USA)	12	T7	4
17	FRG	6	T7-T5	6
18	(Argentina/USA)	12	T7	4
19				
20	France			
21	FRG	6	T7-T5	6
26				
IX 1	Australia	20-2HD	T7	20/Section-12
2	Australia	1	T7	12
3	France	20	T4	4
4				
5				
6	(Mauritius/Pakistan/France/India)			
7	Australia (Partial)	16	T7	16/Section
9	Australia	14	T4	50/Section
10	France	5	T7	4
11				
12	Australia	12	T4	50/Section
13	France/Japan			
14				
19	France			
21	(Argentina/USA)			
22	Australia	12	T7	30/Section
23	(France)			
PX 1	TRANSPAC - Canada/USSR/USA/Japan			
2	TOGA XBT Network			
3				
4	Japan/USA/France	4 HD	DB/XCTD	12
5	USA/Taiwan - Start 91	4 HD	DB/XCTD	12
6	USA - Start 91	4 HD	DB/XCTD	12
7	USA - Start 92	4 HD	DB/XCTD	12
8	USA - Start after 94			
9	USA	4 HD	DB/XCTD	12
10	USA	4 HD	DB/XCTD	12
11	USA - Start 91	4 HD	DB/XCTD	12
12	USA - Start after 94			
12A	(Australia)			
13	Australia 2 HD	T7	12	
14				

*Brackets indicate line under consideration, HD - High Density (30-40 km spacing)

WHP One-Time Survey

There are two significant factors to be taken into consideration when evaluating WHP one-time survey commitments. Firstly the Large Volume Sampling (LVS) programme is presently sporadic at best, and secondly, the commitments span the period 1990-1997. The latter means that the full data set will only become available in 1999 and, furthermore, the WOCE "snapshot", from which initial conditions are determined for integration of models, will become less focussed. If some of the high quality data obtained during the latter part of the 1980s were utilized for WOCE purposes, the overall level of commitment to the one-time survey is considerable and there are no major gaps in the T, S and small volume sampling.

Atlantic Ocean

The Atlantic Ocean south of 5°N is the site of the CP3 Deep Basin Experiment and has received high priority during the 1991-1993 period. For the Atlantic Ocean north of 5°N, interest has been expressed for all sections; sections A1 and A2 are firmly committed at this time. Other of these sections will be occupied more within the repeat mode than as one-time survey sections.

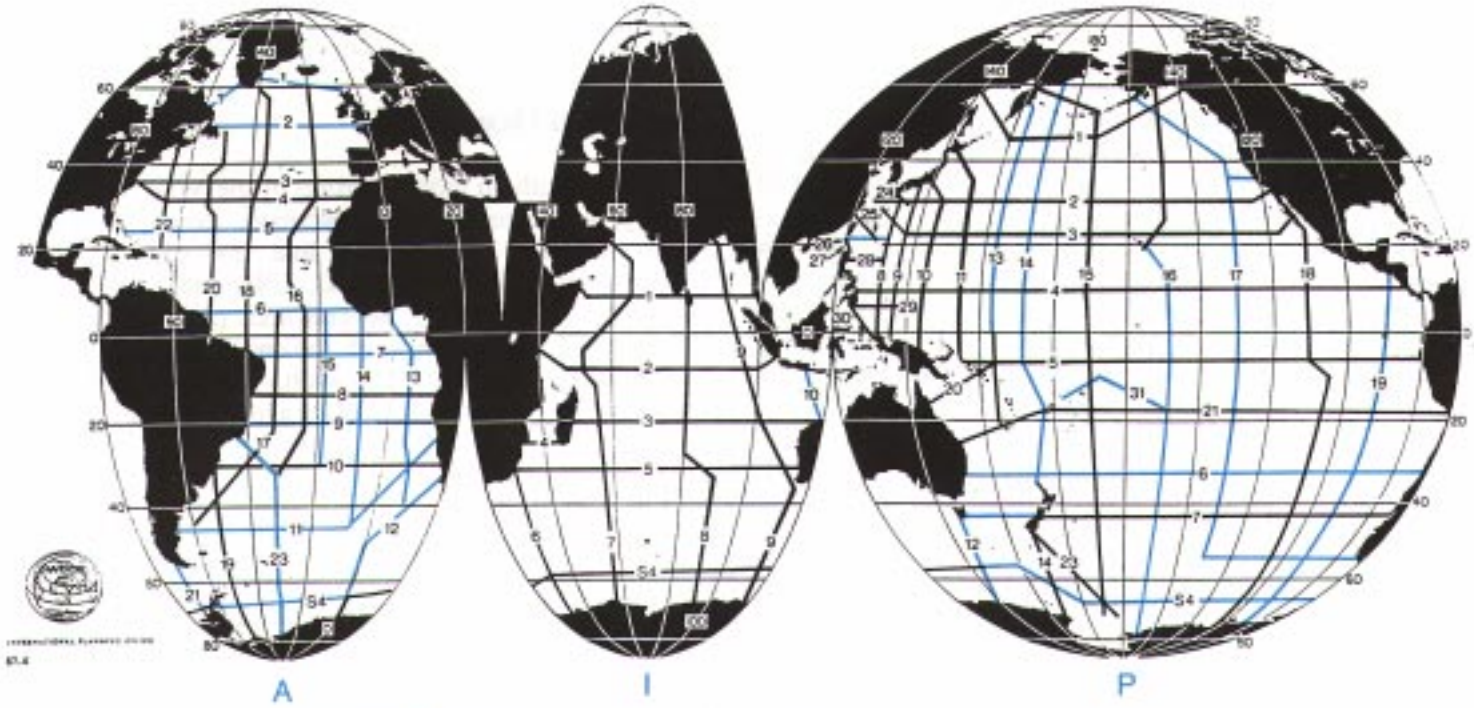
Indian Ocean

In terms of overall coverage of the WHP one-time survey in the Indian Ocean, the picture is fairly bright. The span over which the lines will be occupied, however, could be a decade. The line I10 was occupied in 1989 by France and I5 in 1988 by the USA, both without LVS. There is some interest in re-occupation of both. The bulk of the lines will be occupied to full WOCE specifications in the 1995-97 period by the USA. France plans to occupy I4, I6 and I7 (south of 20°S) in the 1993/94 period and the USSR will complete the network of lines by occupying I7 (north) without LVS at an unspecified date.

WHP: Timetable for One-time Survey

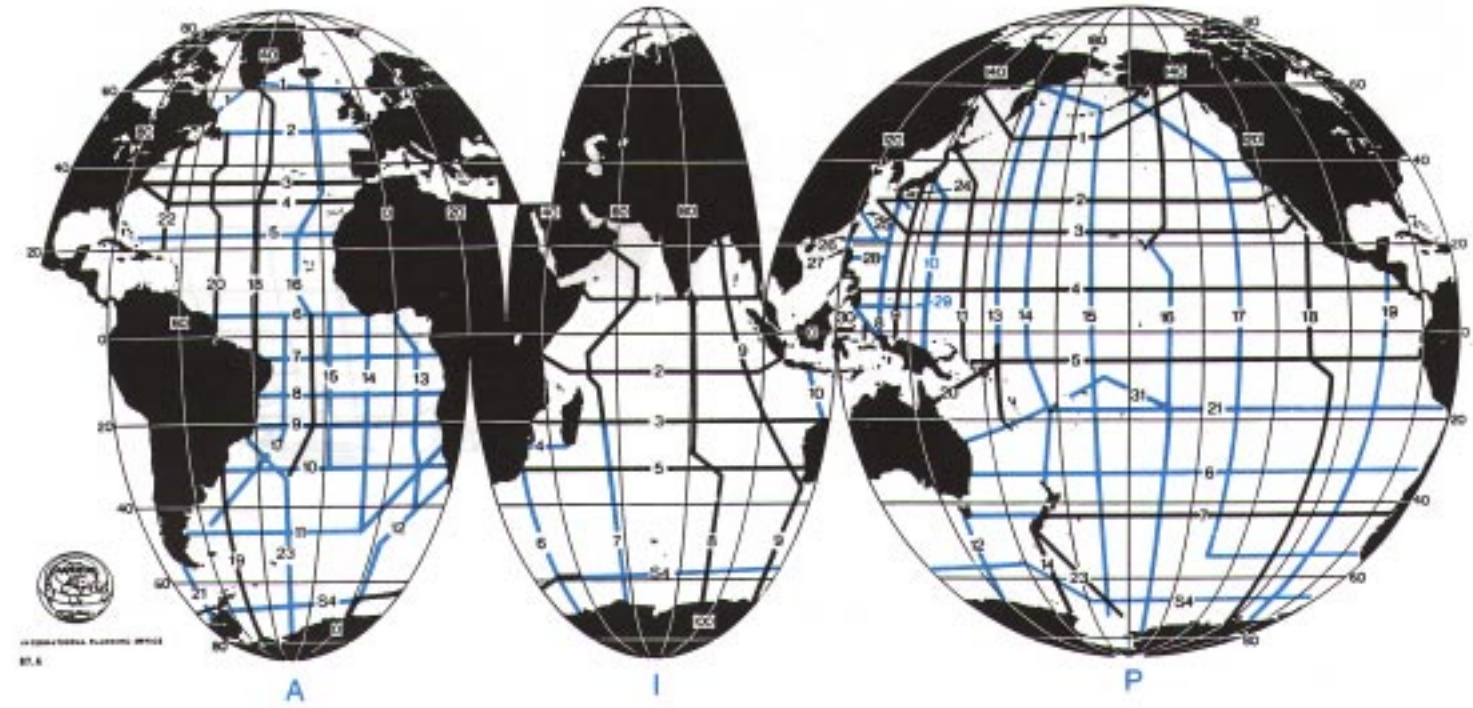
1990		1991		1992		1993		1994		No Date		No Date	
A12	FRG	A1	Can/FRG	A5	Sp	A10	FRG	A17	FRG/F	A3	USSR	P18	US
(S2)		A2	Can/FRG		US (or 96)	P8	PRC	P24	PRC/J	A4	USSR	P20	US/Aus
A21	FRG	A9	FRG	A6	F	P10	US	S4	USSR (IO)	A16	US (South)	S4	FRG
(S1)		P6	US/Aus	A7	F	P21	US/Aus	I6	F	A18	US	I1	US
P19	US	P7	US	A11	UK	P25	PRC			A19	Arg	I2	US
S4	FRG (S.Atl)		(Tas-Sea)	A13	FRG/F	P27	Taiwan/Phil			A20	US/USSR	I3	US
I10	F (89)	P13	J	A14	F	P28	PRC/Phil				(N of A4)	I5	Aus/
		P16	US (South)	A15	US	P29	PRC/Phil			A22	US		(US, 88)
				A23	UK	P30	PRC/Phil			P1	USSR	I7	USSR
				P14	US	S4	Aus/FRG/			P2	J, USSR		(N of 7S)
				P17	US		US (Pac)				(W of P14)	I8	US/USSR
				P26	Taiwan	I4	F			P4	US (89),	I9	US/USSR
				P31	US	I7	F (South)				USSR		
				S3	US						(E of P17)		
				(P12)						P5	US		
				S4	USSR (Pac)					P7	Chile/US		
					Aus (IO)			1995		P9	J	Uncommitted	
										P11	J, USSR		
								A8	FRG		(N of P2)	P3	
								A16	UK (North)	P16	USSR	P14	(NZ-AA)
								P15	Can/Aus		(North)	P23	

WHP One time Survey



Key: ——— funded or funding under consideration for 1990-1992

WHP One-time Survey



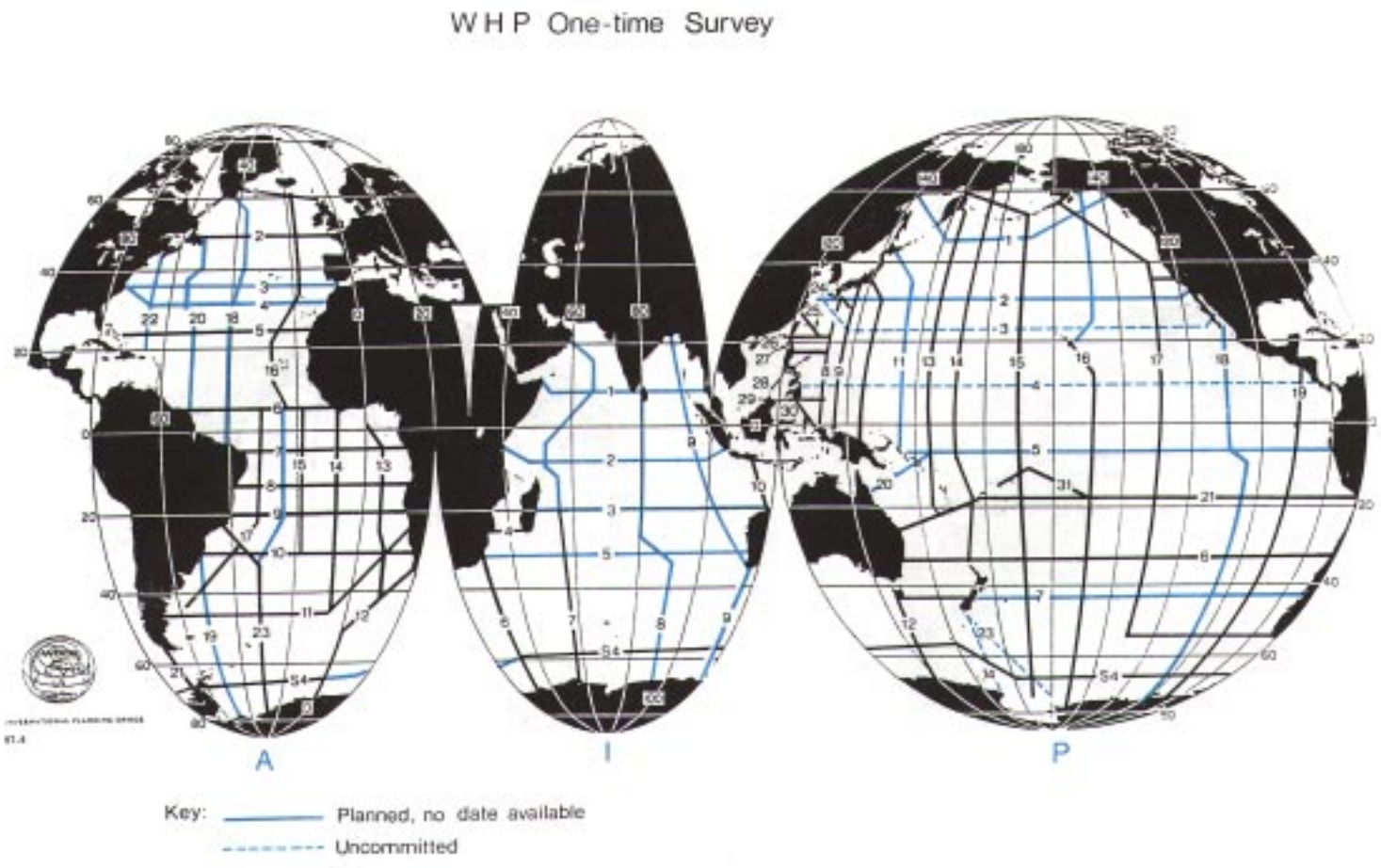
Key ——— funded or funding under consideration for 1990-1995

Pacific Ocean

The Pacific basin, like the South Atlantic, will have a large percentage of its one-time survey lines occupied during the 1990-1993 period. Pacific sections P3, P14 (south of Tasmania) and P23 are the only WHP one-time survey lines which have generated no interest. P4 was completed in 1989 and P3 was given low priority because it too had been occupied in the 1980s. Unless additional support is obtained for P1 and P2, the set P1-4 will be occupied totally without LVS. Only the portion of the important meridional heat flux section P2 west of Hawaii is planned (Japan and USSR).

Southern Ocean

The Southern Ocean portion of the WHP one-time survey is reasonably well subscribed. Nine latitudinal lines and the circumpolar line S4 (through the co-operation of Australia, FRG, USA and USSR) will be completed by 1995. Several lines (A19, I8, I9 and P18) will be occupied towards the end of WOCE. There are no plans for a P14 occupation. The Core Project 2 Working Group has assigned P23 a lower priority.



WHP: One-time Survey Details

	Line	Country	Co-ordinators	Period	Ship
1990	A12/S2	FRG	W Roether	Jan	Meteor
	A21/S1	FRG	W Roether	Mar	Meteor
	P19	US	A Huyer, J Swift	Oct-Nov	Knorr
	S4 (part)	FRG	W Roether	Feb	Meteor
	I10	F	M Fieux	Aug 89	Marion Dufresne
1991	A1	Can/FRG	A Clarke, J Meincke	M-J/O-N	Meteor
	A2	Can/FRG	A Clarke, J Meincke		
	A9	FRG	G Siedler	Feb-Mar	Meteor
	P6	US/Aus	M McCartney, J Church	Sept-Nov	Melville
	P7 (Tas-Sea)	US	J Toole	Nov	Melville
	P13	Japan	K Taira	Aug-Oct	Hakuho Maru
	P16 (S)	US	L Talley, J Swift	Feb	Knorr
1992	A5	Sp/US			
	A6	F	H Mercier		Atalante
	A7	F	H Mercier		Atalante
	A11	UK	P Saunders		Ross/Discovery
	A13	F/FRG	M Arhan		Atalante
	A14	F	M Arhan		Atalante
	A15	US	W Smethie		
	A23	UK	K Heywood		Ross/Discovery
	P14	US	D Roemmich, B Cornuelle, G Roden	Mar-June	
	P17	US	D Musgrave, L Talley, J Reid, J Swift, M Tsuchiya	Aug 1992-Jan 1993	
	P26	Taiwan	C Liu		Ocean Researcher
	P31	US	D Roemmich, N Bray	Feb	
	P12/S3	US	T Joyce	Jan	Melville
	S4 (part)	USSR (Pac)/Aus			Aurora Australis
1993	A10	FRG			
	P8	PRC	D Hu		Science I
	P10	US	M Hall	June	
	P21	US/Aus	H Bryden, J Church	Feb-May	Aurora Australis
	P25	PRC	D Hu		Science I
	P27	Taiwan/Phil	C Liu		
	P28	PRC/Phil	D Hu		Science I
	P29	PRC/Phil	D Hu		Science I
	P30	PRC/Phil	D Hu		Science I
	S4 (part)	US/Aus/FRG	S Jacobs, J Swift	Jan-Mar	Aurora Australis
	I4	France	M Fieux	August	Marion Defresne
	I7	France	A Poisson	Jan-Feb	Marion Dufresne
1994	A17	F/FRG	A Colin de Verdière		
	P24	J/PRC			
	I6	F	A Poisson	Jan-Feb	Marion Dufresne
	S4 (part)	USSR (IO)			
1995	A8	FRG	G Siedler		Meteor
	A16	UK			
	P15	Can/Aus			Parizeau/ Aurora Australis

WHP Repeats

The commitment to the WHP repeat sections, *ie* those repeats which are neither CP3 Control Volume Experiments (CVEs) or the Special Survey areas of the Indian Ocean, is at the 60-65% level of requirement. Only the section IR5 is totally neglected and several others, PR7, 9, may be occupied using XBT/XCTDs rather than CTDs. The commitment to the Special Survey areas ISS1, ISS2 and ISS3 and to CVEs I and II is minimal. Floats and current meter moorings, as well as CTD measurements are required in the ISSs. There are no cohesive plans for the occupation of these areas at the present time; discussion of detailed plans has begun.

The Pacific repeats are based to a large degree on ongoing projects of Japan, China, Canada, Australia, France, Peru and the USA and therefore a systematic repeat network can be achieved without many additional resources.

The basic Indian Ocean requirement is to occupy sections in the winter and summer extremes, once within the full one-time survey and the other as a repeat. With the level of interest expressed this appears to be possible except along IR5 (Bangladesh to Australia). The southern portion of IR5 is the western boundary of ISS3 but most of the ISS3 activity identified thus far is in the eastern sector. An extensive measurement programme will be carried out by India and the USSR in ISS2; discussions are underway to evolve a more extensive programme in ISS2 based on the India/USSR work.

In the Atlantic, there are sufficient commitments to undertake the Deep Basin Experiment (AR15) and the Control Volume Experiments III (AR12) and IV (AR13). The DBE is scheduled for 1991-1993 and the CVEs for 1993-1994. There are no plans at present for repeat hydrography within CVEs I (AR10) and II (AR11). Elsewhere, there is interest in all sections but firm commitments cannot be identified for ARs 4, 8, 16 and 17. The northern repeats, AR7 and AR18, are well subscribed and the repeat of A2 (in conjunction with AR12 and AR13) will be undertaken. USSR Sections programmes are to be carried out in the tropical Atlantic, the Labrador Sea and the Norwegian and Greenland Seas; discussions have been initiated to evolve these programmes into repeat hydrographic programmes.

There are commitments for repeat hydrography on SR2 and SR3 in the Southern Ocean. For SR1 and SR4 plans are under discussion.

Atlantic Ocean

	Location	Requirement	Commitment/Interest	
AR1	24°N	4x		Spain, GDR
AR2	30°S	4x	1x	FRG, Argentina
AR3	NE US Coast	8x	8x	USA (after 1993)
AR4	40°W off Brazil	4x	3x	FRG, USA, USSR, Columbia, Brazil, France
AR5	Greenland to 33°N	4x	2x	Canada, USSR
AR6	Lisbon-Morocco	4x	1x	UK, USSR
AR7/E	57°N Iceland-Greenland	3/a	10x	FRG, UK, USSR, Netherlands, Canada
AR7/W	E Greenland-Labrador	1/a	1/a	Canada, FRG
AR8	South America Coast	8x		France, FRG, Argentina, Uruguay
AR9	South Africa Coast	4x	2x	South Africa
AR10	CV I	4x		USA (TRE), Canada
AR11	CV II	4x		USA (Subduction), Canada
AR12	CV III	4x	4x	UK, FRG, Netherlands, Canada
AR13	CV IV	4x	4x	Canada, FRG, Netherlands, USSR, USA
AR14	CV V	4x		USA, USSR
AR16	West Iberian	1x		Spain, Portugal, France, GDR, USSR,
AR17	5°N and 5°S	1x		FRG, France, USSR, GDR, USA
AR18	Faeroe-Iceland-Greenland	4/a	20x	Iceland, Denmark
AR15	DBE	-	Moored arrays, Hydro/Tracer Cruises plus WHP one-time survey, Floats	USA, FRG, France

Pacific Ocean

	Location	Requirement	Commitment	Commitment/Interest
PR1	130°E	1/a	1/a	PRC - Partial
PR2	137°E	2/a	2/a	Japan
PR3	144°E	1/a	1/a	Japan
PR4	155°E	1/a	1/a	Japan
PR5/6	Canada to Papa	4/a	4/a	Canada
PR7/8	Alaska to Papa	4/a		
PR9/10	USA to Papa	2/a		
PR11	28°S	4/a	6-8/a	Australia
PR12(SR3)	Tasmania-Australia	1/a	1/a	Australia
PR13	Tasmania-NZ-Australia	1/a	1/a	Australia - partial
PR14	40°S, 80°W	1-4/a	2/a	Chile
PR15	Equator 165°E	2/a	2/a	France
PR16	Equator 110°W	2/a	2/a	USA, USSR
PR17	Kyushu SW	4/a	1/a	Japan, PRC
PR18	China-24°N	2-4/a	1/a	PRC
PR19	China-Ryuku	2/a	1/a	PRC
PR20	Taiwan-130°E	2/a	2/a	Taiwan
PR21	Taiwan-Luzon	2/a	1/a	Taiwan, Philippines
PR22	Luzon-130°E	2/a	1/a	PRC, Philippines
PR23	Mindanao-130°E	2/a	1/a	PRC, Philippines
PR24	Mindanao-Indonesia	2/a	1/a	PRC, Philippines
PR25	12°S, 80°W	1/a	1/a	Peru

Indian Ocean

	Location	Requirement	Commitment/Interest
IR1	8°N	1x	FRG, USSR (W of 80°E)
IR2	8°S	1x	Australia, USSR (W of 80°E)
IR3	Arabia to 10°S	1x	USSR
IR4	Sri Lanka - 10°S	1x	FRG
IR5	Bangladesh to Australia	1x	
IR6	Java to Australia	1x	Australia, France, FRG, USA
ISS1	SW Indian Ocean	CTD, floats, CM Moorings	South Africa, UK
ISS2	NW Indian Ocean	CTD, ADCP, CM Moorings, A/S flux meas.	FRG, USSR, India
ISS3	Indo/Pacific Throughflow	CTD, CM Moorings	FRG, Australia, France, USA

Southern Ocean

	Location	Requirement	Commitment	Commitment/Interest
SR1	Drake Passage	4x	1x	Chile, Argentina, Uruguay, Peru
SR2	South Africa-Antarctic	4x	3x	South Africa, FRG
SR3	Australia-Antarctic	4x	8x	Australia
SR4	Weddell Sea	2x	4x	FRG, Argentina, UK

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DACs for current-meter and float data are under negotiation

Further details on these facilities can be obtained from the WOCE International Project Office and through the Data Information Unit. General details as to the objectives of these facilities are given in the WOCE Implementation Plan, Vol.I, Detailed Requirements (WCRP-11, WMO/TD No. 242, 1988).